

UDC 597.551.2(594)

LENGTH-WEIGHT RELATIONSHIPS AND CONDITION FACTORS OF THE NALEH FISH, *BARBONYMUS GONIONOTUS* (PISCES, CYPRINIDAE) HARVESTED FROM NAGAN RAYA WATERS, INDONESIA

A. S. Batubara¹, Z. A. Muchlisin^{1,2*}, D. Efizon³, R. Elvyra⁴, M. Irham²

¹Graduate Studies, Universitas Syiah Kuala, Banda Aceh, Indonesia

²Faculty of Marine and Fisheries, Universitas Syiah Kuala, Banda Aceh, 23111 Indonesia

³Faculty of Fisheries and Marine Science, Universitas Riau, Pekanbaru Indonesia

⁴Faculty of Sciences, Universitas Riau, Pekanbaru Indonesia

*E-mail: muchlisinza@unsyiah.ac.id

Length-Weight Relationships and Condition Factors of the Naleh Fish, *Barbonymus gonionotus* (Pisces, Cyprinidae) Harvested from Nagan Raya Waters, Indonesia. Batubara, A. S., Muchlisin, Z. A., Efizon, D., Elvyra, R., Irham, M. — The objective of the present study was to examine the growth pattern and condition factors of the naleh fish, *Barbonymus gonionotus* Bleeker, 1849 in Nagan River, Nagan Raya District, Aceh Province, Indonesia. The sampling was conducted for 12 months from January 2016 to December 2016 using the explorative survey method. The sampling locations were determined based on the information given by local fishermen. A total of 761 fish samples were collected during the study. The Linear Allometric Model (LAM), Fulton's and Relative Weight conditions factors were utilized to analyze the length-weight relationship and condition factor of the fish using growth parameters. The results showed that the highest coefficient of b was recorded in December, where the b value of males were 3.82 and 4.23 for the females with the average b value of males and females were 2.92 indicating an isometric growth pattern. The average Fulton's condition factor (K) was 2.28 and the average Relative weight (Wr) condition factor was 100.59. It is concluded that fish had the isometric growth pattern and based on K and Wr value, the result implies that the waters are still in a good condition. Furthermore, the availability of food sources, low competitors, and low predators indicate that the aquatic environment is in a stable condition.

Key words: condition, growth, environment, *Barbonymus*.

Introduction

Aceh is one of the provinces that has the highest freshwater fish diversity in Indonesia. There were at least 155 species of freshwater fish recorded in Aceh waters (Muchlisin and Siti-Azizah, 2009; Muchlisin, 2012; Muchlisin et al., 2013; Sarong et al., 2013; Muchlisin et al., 2014; Muhammadar et al., 2014; Akib et al., 2015; Muchlisin et al., 2017) where several species have a commercially important value (Muchlisin, 2013), one of



Fig. 1. Fresh sample of naleh fish *Barbonymus gonionotus*.

which is naleh *Barbonymus gonionotus* Bleeker, 1849 (fig 1.). This species is commonly found in several rivers in Nagan Raya District, Indonesia (Muchlisin et al., 2015 a).

The naleh *B. gonionotus* is very promising as a target for aquaculture (Mollah et al., 2011). They have a bright and attractive color, especially in the dorsal, caudal and anal fins. Therefore, this species is very suitable as an ornamental fish. However, the wild population of the naleh fish in Nagan Raya waters has been unfortunately declining over the last ten years (Personal communication with the fishermen of Nagan Raya). This is probably due to the deforestation, overfishing, and unfriendly fishing practices by local fishermen. According to Sodhi et al. (2004), Southeast Asia (including Indonesia) has very high deforestation rates compared to other tropical regions and is expected to lose 75 % of its original forest by 2100 and 42 % of total biodiversity is also likely to be lost. In addition, the high catching rates without size limits occur continuously so that the new progeny recruitment decreases significantly.

The direct observation of habitat of naleh *B. gonionotus* during the sampling in the Nagan River showed that the dominant fish species was Nile tilapia *Oreochromis niloticus*. According to Muchlisin (2012), *O. niloticus* is one the alien fish species that was distributed widely in Aceh waters; this is an invasive fish species in the world (Lowe et al., 2000; Brown and Sax, 2004; Singh and Lakra, 2011).

The biology of the *B. gonionotus* from the Padma River, Bangladesh has been reported by Jasmine and Begum (2016), however, there was no information on the biology especially on the length-weight relationship and condition factors of this species in the Nagan River, Indonesia. Indeed, the IUCN conservation status of the *B. gonionotus* is the Least Concern (Thinh et al., 2012), however, the local fishermen in Nagan Raya District, Indonesia claimed that the catch of naleh decreased and the fish caught was smaller compared to 10 years ago. According to Froese and Torres (1999) that freshwater fish are 10 times more vulnerable to the threats than brackish and marine fishes. This is because the damage of freshwater ecosystem is very high compared to other ecosystems (Sodhi et al., 2004). Consequently, the conservation status of this fish must be reevaluated and the conservation strategies should be developed soon. Therefore, the information on the length weight relationship (LWS) and condition factors are the two important data to plan a better conservation strategy of fishery resource (Muchlisin et al., 2010; Freon et al., 1997; Arredondo et al., 2016; Nash et al., 2006; Satrawaha and Pilasamorn, 2009; Froese, 2006; Garcia, 2010). Hence, the objectives the present study were to analyze the length-weight relationships and condition factors of the naleh *B. gonionotus* harvested from Nagan River, Nagan Raya District, Indonesia.

Material and methods

Time and site

The sampling was conducted in the Nagan River, Nagan Raya District, Aceh Province Indonesia at the coordinate of 4°16'25.25" N and 96°24'22.34" E; 4°17'4.73" N and 96°25'56.83" E; 4°16'48.49" N and 96°27'8.50" E from January to December 2016 (fig. 2). The measurement and data analysis were conducted in Laboratory of Ichthyology, Syiah Kuala University, Indonesia.

Sampling procedure

The sampling locations were determined purposively based on information from local fishermen at the sites where naleh fish usually occurred. The samplings were performed twice a month from 8.00 AM to 4.00 PM for 12 months. The fish were caught using casting nets with two mesh sizes (0.5 and 1.0 inches) and line hooks.

The sampled fish were weighed and measured for each body weight (g) and total length (mm) using a digital balance (Toledo, AB-204. Error = 0.01 g) and digital calipers (Mitutoyo, CD-6CS. Error = 0.01 mm). The samples were photographed prior to be preserved in 10 % formalin (Muchlisin et al., 2015 b).

Length-weight relationships and condition factors analysis

The Linear Allometric Model (LAM) was utilized to examine the length-weight relationship based on De-Robertis and William (2008) as follow:

$$W = e^{0.56} (aL^b),$$

where, W is body weight (g), L is total length (mm), a is the regression intercept, b is the regression coefficient and e is the variance of the residuals from the LAM regression. **0.56** is the correction factor of the data sets.

The Relative Weight (Wr) and Fulton's (K) condition factors were used in this study. The Wr was calculated based on Rypel and Richter (2008) as follow:

$$Wr = (W / W_s) \times 100,$$

where, Wr is the relative weight, W is the body weight of the fish sample (g), W_s is predicted body weight for the same fish as calculated from a composite of length-weight regression throughout the range of the species: $W_s = aL^b$.

The Fulton's condition factor was calculted based on Muchlisin et al. (2010) as follow:

$$K = (W \times L) - 3 \times 100,$$

where, K is Fulton's condition factor, W is body weight of the fish sample (g), L is total length of the same fish sample (mm), -3 is a coefficient to ensure that the K value tends toward one. Based on Morton dan Routledge (2006) the K value is divided into five categories as follows: Very bad (0.8–1.0), Bad (1.0–1.2), Balance (1.2–1.4), Good (1.4–1.6) and Very good (> 1.6).

Results

A total of 626 males and 135 females from fish samples were examined for the LWS and conditions factors analysis. The male length ranged between 70 mm to 147 mm with the average length of 93.35 ± 14.71 , while the female length ranged from 72 mm to 144 mm with the average length of 101.02 ± 16.54 . The average b value of male fish was 2.92 and 3.03 for female, with the higher b value was detected in December for both males and females, but there was no significant difference in b values during 12 months of the sampling period (table 1). The average b value indicates that males had allometric negative growth pattern,

Table 1. The growth patterns and condition factors of the *B. gonionotus* males and females according to sampling period

Month	Male						Female					
	N	b	R ²	r ²	K	Wr	N	b	R ²	r ²	K	Wr
January	70	2.82	0.9294	0.964	2.35	100.81	13	3.11	0.9118	0.9548	2.43	100.98
February	54	2.83	0.9632	0.9814	2.32	100.09	11	3.11	0.9523	0.9758	2.29	100.41
March	51	2.57	0.9552	0.9773	2.35	100.36	6	2.57	0.984	0.9919	2.52	100.13
April	75	2.89	0.9268	0.9627	2.25	101.07	8	3.42	0.9855	0.9927	2.67	100.23
May	57	2.85	0.9458	0.9725	2.31	100.25	10	2.52	0.9327	0.9657	2.27	100.14
June	52	3.19	0.965	0.9823	2.15	100.37	7	2.97	0.9702	0.9849	2.3	100.13
July	52	2.55	0.9565	0.978	2.27	100.26	9	2.5	0.9602	0.98	2.45	100.42
August	51	2.73	0.972	0.9859	2.29	100.31	15	2.42	0.932	0.9653	2.42	100.37
September	43	2.74	0.9477	0.9735	2.28	100.13	8	2.7	0.9757	0.9877	2.34	100.08
October	56	2.64	0.9191	0.9586	2.11	100.22	4	3.88	0.9032	0.9503	1.99	100.38
November	39	3.32	0.8996	0.9485	2.16	101.19	18	2.97	0.9174	0.9578	2.43	100.61
December	26	3.82	0.8936	0.9453	2.37	101.87	26	4.23	0.9506	0.9749	2.08	101.27
Average	626	2.91	0.9394	0.9692	2.27	100.57	135	3.03	0.9479	0.9734	2.35	100.43

Note. N = total sample, b = regression coefficient, R^2 = determination coefficient, r = correlation coefficient, K = Fulton's condition factor, Wr = relative weight condition factor.

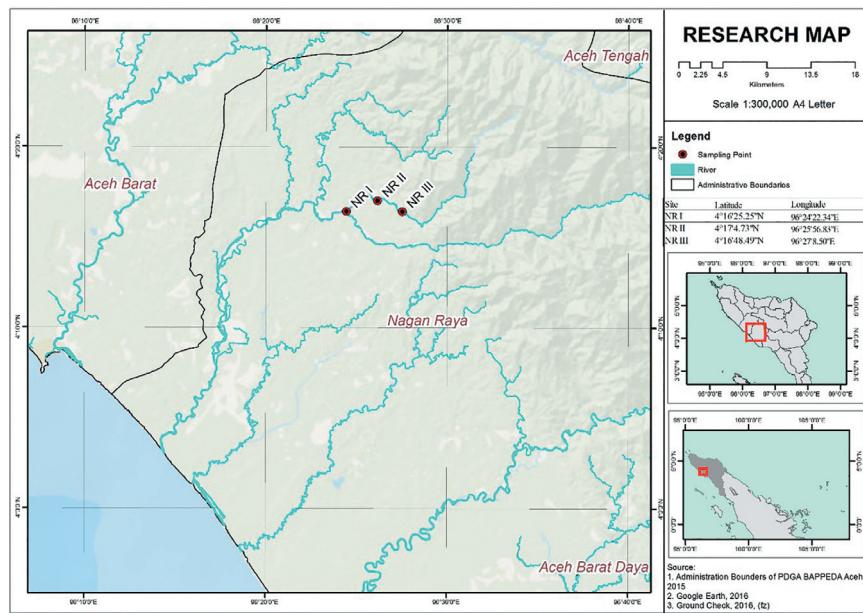


Fig. 2. Map of Nagan Raya District, Aceh Province showing location sampling (black dots).

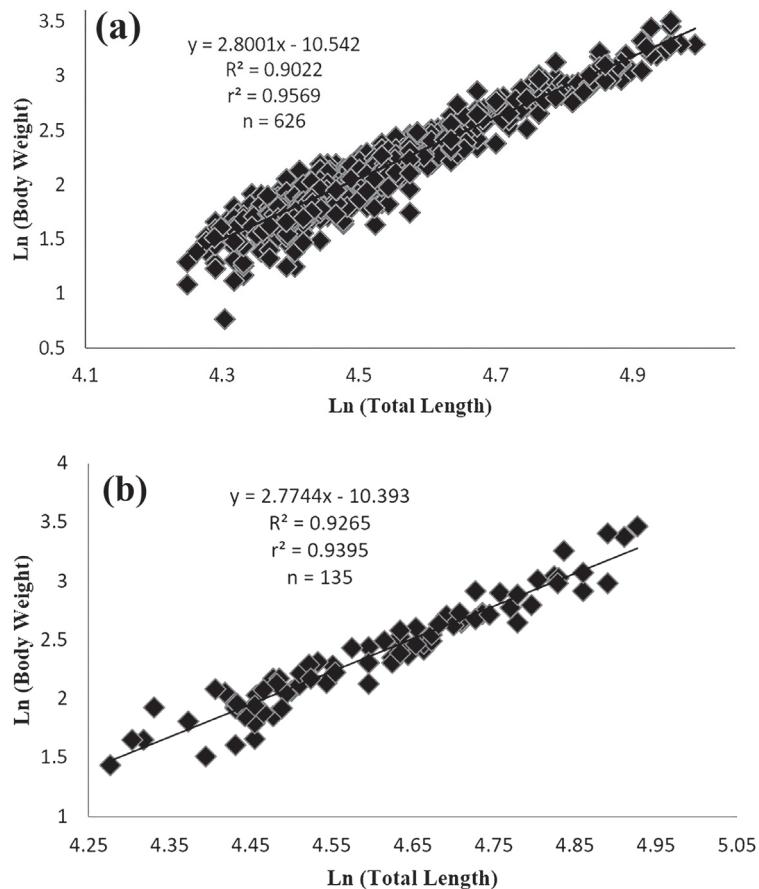


Fig. 3. Length-weight relationship for *B. gonionotus* males (a) and females (b) sampled from January 2017 to December 2017. Observed growth curve of *B. gonionotus* males, $y = 2.8001x - 10.542$, $R^2 = 0.9022$, and females, $y = 2.7744x - 10.393$, $R^2 = 0.9265$.

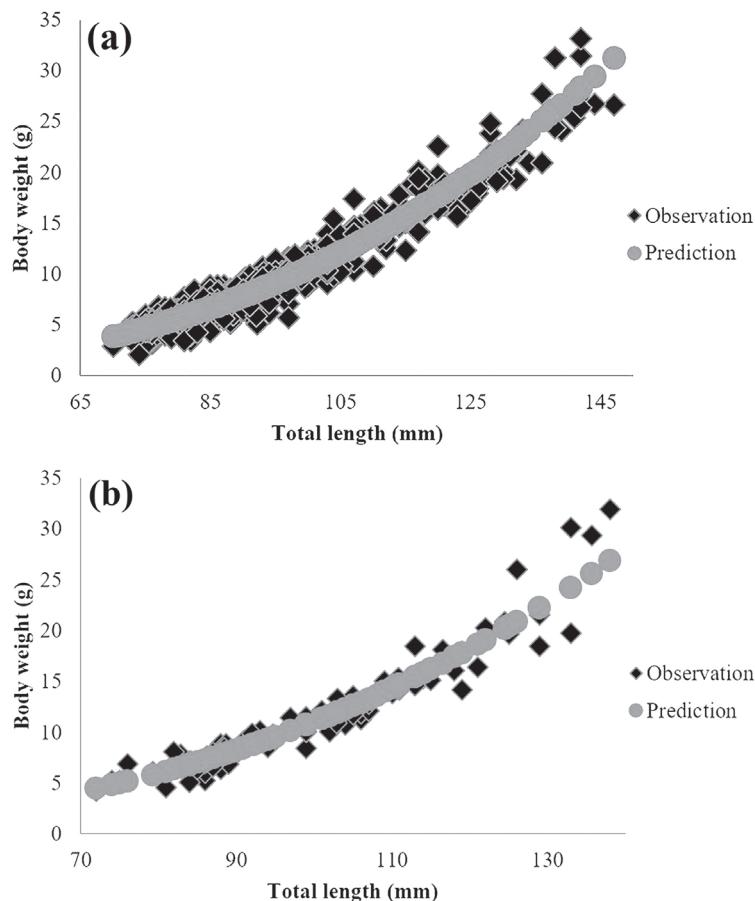


Fig. 4. Comparison of observed and predicted growth for *B. gonionotus* males (a) and females (b) sampled during January 2017 to December 2017. Total number of fish = 135 females, 626 males. Predicted growth curve for males, $y = 0.317x - 20.3$ $R^2 = 0.970$, and for females: $y = 0.330x - 21.40$, $R^2 = 0.979$.

while females have an isometric growth pattern; Nevertheless, the values are close to 3 and therefore both sexes are isometric growth pattern.

Observed growth curve of *B. gonionotus* for males is $y = 2.8001x - 10.542$ with $R^2 = 0.9022$ and for females is $y = 2.7744x - 10.393$ with $R^2 = 0.9265$ (fig. 3, a, b). While, observed growth curve for males is $y = 0.317x - 20.3$ with $R^2 = 0.970$ and for females is $y = 0.330x - 21.40$ with $R^2 = 0.979$ (fig. 4, a, b). The determination coefficient (R^2) for males and females ranges from 0.8936 to 0.9720 and from 0.9036 to 0.9855, respectively. It means that 89 % to 96 % of variant can be explained by the model. While, the correlation coefficients (r) were higher than 90 % for males and females, which informs the positive and strong relationship between weight and length (table 1).

The average Fulton's condition factor for males and females was 2.27 and 2.35, respectively; while the relative weight (Wr) condition factor of males ranged from 100.07 to 101.87 with the average value of 100.57 ± 0.84 , whereas the Wr of females ranged from 100.08 to 101.27 with the average value of 100.43 ± 0.35 (table 1).

Discussion

The study revealed that males were predominant in the population, although the females were larger than male. In general, The Linear Allometric Model analysis showed that there was a variation of b values during 12 months sampling where the value was higher in December for males and females. However, the values tended to 3 that indicates an isometric growth pattern. The difference was probably due to the changes in food availability and gonad maturation. According to Moradinasab et al. (2012), the b value is influenced by sex, gonad development, seasons, habitat, feed, stomach fullness, salinity, and temperature. Besides, the b value was also affected by genetic and ecological conditions (Nash et al., 2006).

The b values were higher in rainy season during October to December. This is probably due to the runoff that dissolves the nutrients on the topsoil through waters body thus triggering the growth of planktons as a food for larvae and small fish and it is associated with the food chain in the waters. According to Muchlisin (2010), the seasonal changes cause fluctuations in food resources in waters and affect the growth condition of fishes.

The Fulton's condition factor (K) of naleh was fallen into a very good category with the average value of 2.27 and 2.35 for males and females, respectively. According to Jin et al. (2015), Fulton's condition factor is used to evaluate the sensitivity and healthy condition of fish. As the growth pattern, the K value is also influenced by age, sex and season (Barnham and Baxter, 1998). The relative weight condition factor (Wr) showed that the value was tending to 100 in both males and females. This result reveals that the environment condition was stable and the density of prey and predator was balanced (Blackwell et al., 2000). Moreover, when the value is higher than 100, it indicates the surplus of food source due to lower competition or predation levels (Muchlisin et al., 2010).

The regression models show that there was not much differences between observed and predicted growth patterns in both males and females, indicating that fish grow in good condition. The similar trend was also reported in *Rasbora tawarensis* and *Poropuntius tawarensis* in Lake Laut Tawar (Muchlisin et al., 2010); 3 species of fishes harvested from Gigieng estuary of Aceh Besar, Aceh Province, Indonesia (Mulfizar et al., 2012); 5 species of groupers harvested from Pulo Aceh waters, Aceh Besar District, Aceh Province (Ramadhani et al., 2017); whitespotted grouper *Epinephelus coeruleopunctatus* from Padang City Waters, Indonesia (Bulanin et al., 2017); and 3 species of marine fishes harvested from Ulehee Bay, Banda Aceh City, Indonesia (Muchlisin et al., 2017). However, the lower value of observed growth pattern compared to predicted growth pattern was reported in *Tor tambra* harvested from the Nagan and Sikundo Rivers (Muchlisin et al., 2015 b).

Conclusions

The b values of male and female naleh were close to 3 indicating an isometric growth pattern. The Fulton condition factor was in very good condition, while the relative weight condition factor indicates stable of environmental conditions and balance of prey and predator.

This study was supported by Kemenristekdikti Republic of Indonesia through PMDSU Research scheme. Therefore, the authors thank Kemenristekdikti for supporting this study.

References

Akib, N. A. M., Tam, B. M., Phumee, P., Muchlisin, Z. A., Tamadoni, S., Mather, P. B., Siti-Azizah, M. N. 2015. High connectivity in *Rastrelliger kanagurta*: influence of historical signatures and migratory behaviour inferred from mtDNA cytochrome b. *Plos One*, 1, 1–18.

Arredondo, M. S. I., Enriquez, E. M., Sanchez, X. G. M., Cardenas, L. A. A., Perez, J. S. R. 2016. Weight-length relationship and condition factor of leopardgrouper *Mycteroperca rosacea* (Perciformes: Serranidae) from the Gulf of California. *California Fish and Game*, **102**, 50–54.

Barnham, C. P. S. M., Baxter, A. 1998. *Condition factor, K, for salmonid fish*. Department of Primary Industries, State of Victoria. 3.

Blackwell, B. G., Brown, M. L., Willis, D. W. 2000. Relative weight (Wr) status and current use in fisheries assessment and management. *Reviews in Fisheries Science*, **8**, 1–44.

Brown, J. H., Sax, D. F. 2004. An essay on some topics concerning invasive species. *Austral Ecology*, **29**, 530–536.

Bulanin, U., Masrizal, M., Muchlisin, Z. A. 2017. Length-weight relationships and condition factors of the whitespotted grouper *Epinephelus coeruleopunctatus* Bloch, 1790 in the coastal waters of Padang City, Indonesia. *Aceh Journal of Animal Science*, **2**, 23–27.

De-Robertis, A., William, K. 2008. Weight-length relationship in fisheries studies: the standard allometric model should be applied with caution. *Journal of Transactions of the American Fisheries Society*, **137**, 707–719.

Freon, P., El-Khattabi, M., Mendoza, J., Guzman, R. 1997. Unexpected reproductive strategy of *Sardinella aurita* off the coast of Venezuela. *Marine Biology*, **128**, 363–372.

Froese, R., Torres, A. 1999. *Fishes under threat: an analysis of the fishes in the 1996 IUCN red list*. In: Pullin, R. S. V., Baitley, D. M. and Kooiman, J., eds. *Towards policies for conservation and sustainable use of aquatic genetic resources*. ICLARM Conf. Proc. 59, 1–277. 1999, Makati City. Philippines, 131–144.

Froese, R. 2006. Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, **22**, 241–253.

Garcia, L. M. B. 2010. Species composition and length-weight relationship of fishes in the Candaba wetland on Luzon Island, Philippines. *Journal of Applied Ichthyology*, **26**, 946–948.

Jasmine, S., Begum, M. 2016. Biological aspects of *Barbonymus gonionotus* (Bleeker, 1849) in the Padma River, Bangladesh. *International Journal of Fisheries and Aquatic Studies*, **4**, 661–665.

Jin, S., Yan, X., Zhang, H., Fan, W. 2015. Weight-length relationships and Fulton's condition factors of skipjack tuna (*Katsuwonus pelamis*) in the western and central Pacific Ocean. *PeerJ*, **9**, 1–11.

Lowe, S., Browne, M., Boudjelas, S., Poorter, M. D. 2000. *100 of the world's worst invasive alien species a selection from the global invasive species database*. Published by The Invasive Species Specialist Group (ISSG) a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), Auckland, New Zealand, 1–12.

Mollah, M. F. A., Moniruzzaman, M., Rahman, M. M. 2011. Effects of stocking densities on growth and survival of thai sharpnose (*Barbonymus gonionotus*) in earthen ponds. *Journal of Bangladesh Agriculture University*, **9**, 327–338.

Moradinasab, G., Daliri, M., Ghorbani, R., Paighambari, S. Y., Davoodi, R. 2012. Length-weight and length-length relationships, relative condition factor and Fulton's condition factor of five Cyprinid species in Anzali Wetland, Southwest of the Caspian Sea. *Caspian Journal of Environmental Science*, **10**, 25–31.

Morton, A., Routledge, R. D. 2006. Fulton's condition factor: is it a valid measure of sea lice impact on juvenile salmon? *North American Journal of Fisheries Management*, **26**, 56–62.

Muchlisin, Z. A., Siti-Azizah, M. N. 2009. Diversity and distribution of freshwater fishes in Aceh Waters, Northern Sumatera, Indonesia. *International Journal of Zoological Research*, **5**, 62–79.

Muchlisin, Z. A., Musman, M., Siti-Azizah, M. N. 2010. Length-weight relationships and condition factors of two threatened fishes, *Rasboratawarensis* and *Poropuntius tawarensis*, endemic to Lake Laut Tawar, Aceh Province, Indonesia. *Journal of Applied Ichthyology*, **26**, 949–953.

Muchlisin, Z. A. 2010. *Diversity of freshwater fishes in Aceh Province with emphasis on several biological aspect of the depik (*Rasbora tawarensis*) an endemic species in Lake Laut Tawar*. Ph.D Thesis, Universiti Sains Malaysia, Penang.

Muchlisin, Z. A. 2012. First report on introduced freshwater fishes in the waters of Aceh, Indonesia. *Archives of Polish Fisheries*, **20**, 129–135.

Muchlisin, Z. A., Thomy, Z., Fadli, N., Sarong, M. A., Siti-Azizah, M. N. 2013. DNA barcoding of freshwater fishes from Lake Laut Tawar, Aceh Province, Indonesia. *Acta Ichthyologica et Piscatoria*, **43**, 21–29.

Muchlisin, Z. A. 2013. Potency of freshwater fishes in Aceh waters as a basis for aquaculture development programs. *Jurnal Iktiologi Indonesia*, **13**, 91–96.

Muchlisin, Z. A., Arfandi, G., Adlim, M., Fadli, N., Sugianto, S. 2014. Induced spawning of seurukan fish, *Osteochilus vittatus* (Pisces: Cyprinidae) using ovaprim, oxytocin and chicken pituitary gland extracts. *AACL Bioflux*, **7**, 412–418.

Muchlisin, Z. A., Akyun, Q., Rizka, S., Fadli, N., Sugianto, S., Halim, A., Siti-Azizah, M. N. 2015 a. Ichthyofauna of Tripa Peat Swamp Forest. Provinsi Aceh. Indonesia. *Check List*, **11**, 1–9.

Muchlisin, Z. A., Batubara, A. S., Siti-Azizah, M. N., Adlim, M., Hendri, A., Fadli, N., Muhammadar, A. A., Sugianto, S. 2015 b. Feeding habit and length weight relationship of keureling fish, *Tor tambra* Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia. *Biodiversitas*, **16**, 89–94.

Muchlisin, Z. A., Batubara, A. S., Fadli, N., Muhammadar, A. A., Utami, A. I., Farhana, N., Siti-Azizah, M. N. 2017. Assessing the species composition of tropical eel (Anguillidae) in Aceh Waters, Indonesia, with DNA barcoding gene *cox1*. *F1000Research*, **6**, 1–258.

Muchlisin, Z. A., Fransiska, V., Muhammadar, A. A., Fauzi, M., Batubara, A. S. 2017. Length-weight relationships and condition factors of the three dominant species of marine fishes caught by traditional beach trawl in Ulelhee Bay, Banda Aceh City, Indonesia. *Croatian Journal of Fisheries*, **75**, 104–112.

Muhammadar, A. A., Mazlan, A. G., Samat, A., Muchlisin, Z. A., Simon, K. D. 2014. Crude protein and amino acids content in some common feeds of tiger grouper (*Epinephelusfuscoguttatus*) juvenile. *AACL Bioflux*, **4**, 499–504.

Mulfizar, M., Muchlisin, Z. A., Dewiyanti, I. 2012. Hubungan panjang berat dan faktor kondisi tiga jenis ikan yang tertangkap di Perairan Kuala Gigieng, Aceh Besar, Provinsi Aceh. *Depik*, **1**, 1–9.

Nash, R. D. M., Valencia, A. H., Geffen, A. J. 2006. The origin of Fulton's condition factor setting the record straight. *Fisheries*, **31**, 236–238.

Ramadhani, A., Muchlisin, Z. A., Sarong, M. A., Batubara, A. S. 2017. Hubungan panjang berat dan faktor kondisi ikan kerapu famili Serranidae yang tertangkap di Perairan Pulo Aceh Kabupaten Aceh Besar, Provinsi Aceh. *Depik*, **6**, 112–121 [In Indonesian].

Rypel, A. L., Richter, T. J. 2008. Empirical percentile standard weight equation for the Blacktail Redhorse. *North American Journal of Fisheries Management*, **28**, 1843–1846.

Sarong, M. A., Mawardi, A. L., Adlim, M., Muchlisin, Z. A. 2013. Cadmium concentration in three species of freshwater fishes from Keuretoe River, Northern Aceh, Indonesia. *AACL Bioflux*, **6**, 486–491.

Satrawaha, R., Pilasamorn, C. 2009. Length-weight and length-length relationships of fish species from the Chi River, Northeastern Thailand. *Journal of Applied Ichthyology*, **25**, 787–788.

Singh, A. K., Lakra, W. S. 2011. Risk and benefit assessment of alien fish species of the aquaculture and aquarium trade into India. *Reviews in Aquaculture*, **3**, 3–18.

Sodhi, N. S., Koh, L. P., Brook, B. W., Peter, K. L. N. 2004. Southeast Asian biodiversity: an impending disaster. *TRENDS in Ecology and Evolution*, **19**, 654–660.

Thinh, D. V., Van, N. S., Nguyen, T. H. T. 2012. *Barbonymus gonionotus*. The IUCN red list of threatened species 2012:e.T166914A1151554. [Cited 2016 November 08]. Available from: <http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T166914A1151554.en>.

Received 26 January 2018

Accepted 25 October 2018